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Applicant:	Michael P. Violette	Examiner: Unknown
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Title:	ANGLED IMPLANT TO IMPROVE HIGH CURRENT OPERATION OF BIPOLAR TRANSISTORS (as amended)	

PRELIMINARY AMENDMENT

BOX PATENT APPLICATION
Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the above-identified patent application as follows:

IN THE TITLE

Please amend the title to read as follows:

"ANGLED IMPLANT TO IMPROVE HIGH CURRENT OPERATION OF BIPOLAR TRANSISTORS."

IN THE SPECIFICATION

On page 1, line 6, before "The present invention", please insert the following:

This application is a division of U.S. Patent Application No. 09/436,306, filed on November 8, 1999, which is a division of U.S. Patent Application No. 09/024,287, filed February 17, 1998, now U.S. Patent No. 5,982,022, which is a division of U.S. Patent Application No. 08/519,817, filed August 25, 1995, now U.S. Patent No. 5,719,082, the specifications of which are incorporated herein by reference.

IN THE CLAIMS

Please cancel claims 1 - 9 without prejudice or disclaimer.

Please add the following new claims:

10. (New) A transistor formed in a semiconductor substrate, the substrate having a first conductivity type and a surface, the transistor comprising:

a collector region having an impurity therein which promotes one of either holes or electrons as a majority carrier, the collector region extending downward from the surface of the substrate, wherein the first conductivity type of the substrate promotes the other of either holes or electrons as a majority carrier;

a base region having an impurity therein which promotes the other type of carrier, the base region having a surface area and extending downward from the surface of the substrate into contact with a portion of the collector region;

an emitter on top of the base region and having a surface area smaller than the surface area of the base region; and

an implant area of the collector region vertically adjacent to the base region having an increased collector doping of an implanted impurity, the implant area having an effective surface area greater than the surface area of the emitter and less than the surface area of the base region.

11. (New) The transistor of claim 10, wherein the transistor is an NPN transistor and the implant impurity in the implant area of the collector region is phosphorous.

12. (New) The transistor of claim 10, wherein the transistor is a PNP transistor and the implant impurity in the implant area of the collector is boron.

13. (New) A transistor formed in a semiconductor substrate, the substrate including a surface and a region doped with an impurity which promotes one of either holes or electrons as a first majority carrier, the transistor comprising:

a collector region having an impurity therein which promotes the other of holes or

electrons as a second majority carrier, the collector region extending from the surface of the substrate;

a base region having an impurity therein which promotes the first majority carrier, the base region extending from the surface of the substrate into contact with a portion of the collector region;

an emitter region on the base region, the emitter region having a surface area smaller than a surface area of the base region; and

an implant region interposed between the collector region and the base region, the implant region having an increased doping of an implant impurity and having an effective surface area greater than the surface area of the emitter region and less than the area of the base region contiguous to the collector region.

14. (New) The transistor of claim 13, wherein the transistor is an NPN transistor and the implant impurity in the implant region is phosphorous.

15. (New) The transistor of claim 13, wherein the transistor is a PNP transistor and the implant impurity in the implant region is boron.

16. (New) The transistor of claim 13, wherein the effective surface area of the implant region minimizes carrier injection from the emitter region to the collector region outside of the implant region at high current operation of the transistor.

17. (New) A transistor formed in a semiconductor substrate, the substrate including a surface and a region doped with an impurity which promotes one of either holes or electrons as a first majority carrier, the transistor comprising:

a collector region having an impurity therein which promotes the other of holes or electrons as a second majority carrier, the collector region extending from the surface of the substrate;

a base region having an impurity therein which promotes the first majority carrier, the

base region extending from the surface of the substrate into contact with a portion of the collector region;

an emitter region on the base region, the emitter region having a surface area smaller than a surface area of the base region;

a first implant region interposed between the collector region and the base region, the implant region having an increased doping of an implant impurity and having an effective surface area greater than the surface area of the emitter region and less than the area of the base region contiguous to the collector region; and

a second implant region formed in the collector region.

18. (New) The transistor of claim 17, wherein the second implant region is formed at about the same level from the surface of the substrate as the first implant.

19. (New) The transistor of claim 17, wherein the collector region includes a plug extending from the surface of the substrate, the plug being separate from the base region.

20. (New) The transistor of claim 19, wherein the second implant region is formed in the plug at about the same level from the surface of the substrate as the first implant region.

21. (New) The transistor of claim 17, wherein the transistor is an NPN transistor and the implant impurity in the first and second implant regions is phosphorous.

22. (New) The transistor of claim 17, wherein the transistor is a PNP transistor and the implant impurity in the first and second implant regions is boron.

23. (New) The transistor of claim 17, wherein the effective surface area of the first implant region minimizes carrier injection from the emitter region to the collector region outside the first implant region at high current operation of the transistor.

24. (New) The transistor of claim 17, wherein the second implant region has a surface area greater then the area of an opening through which the second implant region is formed.

25. (New) A transistor, comprising:

an emitter having an emitter surface area;

a base having a base surface area;

a collector in contact with the base; and

an implant region intermediate the base and the collector, the implant region having an implant surface area greater than the emitter surface area and less than the base surface area.

26. (New) The transistor of claim 25 wherein the collector has a collector surface area, and the implant region surface area is less than the collector surface area.

27. (New) The transistor of claim 26, wherein the base surface area is less than the collector surface area.

28. (New) The transistor of claim 26, wherein the base surface area and the implant region surface area where both contact the collector have a combined area greater than the emitter surface area.

29. (New) The transistor of claim 26, wherein the base directly contacts both the collector and the implant region.

30. (New) A transistor device formed in a semiconductor substrate comprising:

a diffused n well collector region having an impurity of a first conductivity type, the collector region extending downwardly from a surface of the substrate, the substrate being generally doped with an impurity of a second conductivity type;

a base region having an impurity of the second conductivity type doped at a generally constant doping level across a surface thereof, the base region extending downwardly from the

surface of the substrate into contact with a portion of the collector region;

an emitter having an impurity of the first conductivity type on top of the base region and having a surface area smaller than a surface area of the base region; and

an area of the collector region vertically adjacent the base region having an increased collector doping of the first conductivity type, the area of the collector region having an effective surface area in contact with the base region that is greater than the surface area of the emitter.

31. (New) The transistor device of claim 30, wherein the impurity of the first conductivity device is phosphorous.

32. (New) The transistor device according to claim 30, wherein the effective surface area of the collector region is less than less than a non-increased doped area of the portion of the collector region in contact with the base region.

33. (New) A transistor formed in a substrate, the substrate having a first conductivity type and a surface, the transistor comprising:

a collector region having a first impurity means for promoting one of either holes or electrons as a majority carrier, the collector region extending downward from the surface of the substrate, wherein the first conductivity type of the substrate promotes the other of either holes or electrons as a majority carrier;

a base region having a second impurity means for promoting the other type of carrier, the base region having a surface area and extending downward from the surface of the substrate into contact with a portion of the collector region;

an emitter region on top of the base region and having a surface area smaller than the surface area of the base region; and

an implant area of the collector region vertically adjacent to the base region having an increased collector doping of an implanted impurity, the implant area having an effective surface area greater than the surface area of the emitter region and less than the surface area of the base region.

REMARKS

Claims 1 - 9 are canceled and new claims 10 - 33 are added. Claims 10 - 33 are now pending.

The specification is amended to add a cross reference to the prior application. No new matter is added by way of these amendments.

The application filing fee as calculated on the application transmittal sheet reflects the amendments to the claims described above.

The Applicant respectfully requests that the preliminary amendment described herein be entered into the record prior to examination and consideration of the above-identified application.

Respectfully submitted,

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